

# *FAR-ULTRAVIOLET STELLAR EMISSION MEASUREMENTS FROM UVSTAR*

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*Annapolis, September 12-15, 1999: SSPP Symposium*

## *UVSTAR - General Information*

- » UVSTAR is an international payload sponsored by NASA and ASI (Italian Space Agency)
- » Joint experiment: Universities of Arizona & Trieste
- » Goal is to study spectroscopically cosmic sources in the UV bands from 50 to 125 nm
  - planetary targets
  - astronomy targets
  - targets of opportunity

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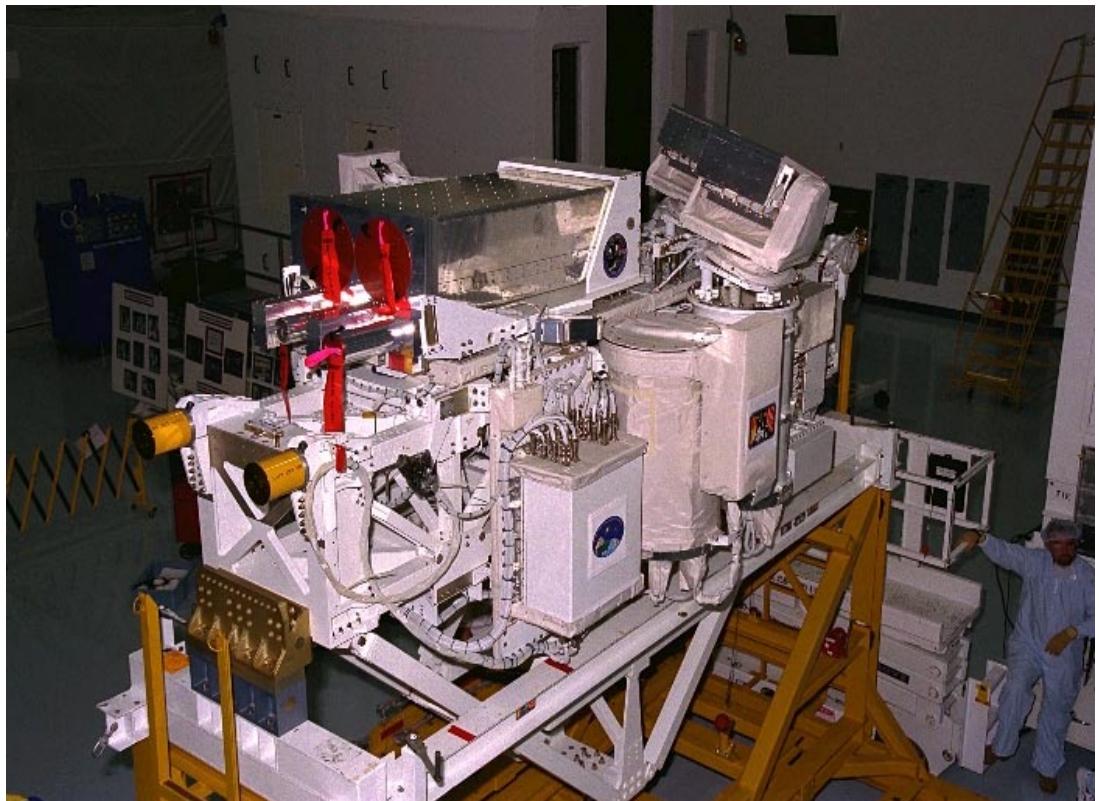
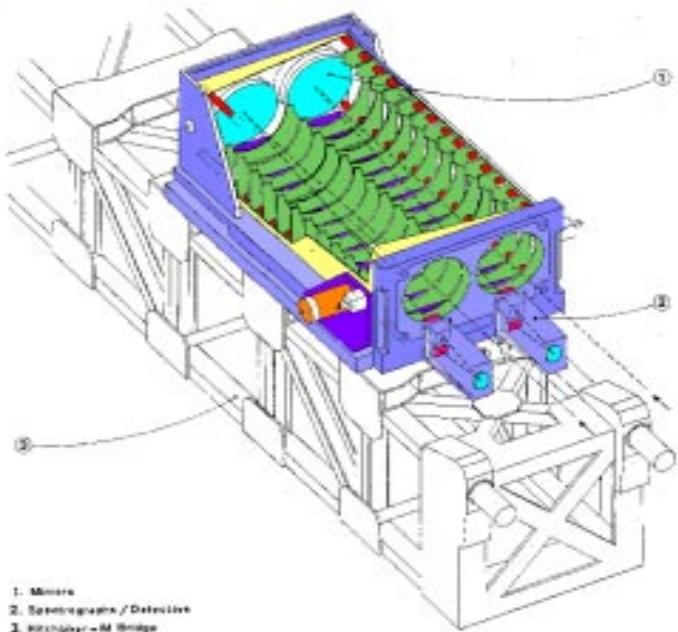
## *UVSTAR Main Characteristics*

- ﴿ *Shuttle Hitchhiker payload*
- ﴿ *Imaging Spectrograph*
- ﴿ *Besides science UVSTAR is used for upgrading instrument/components and testing technologies*
- ﴿ *The experiment was previously flown on STS69 (September 1995), STS85 (August 1997) and STS 95 (October - November 1998)*

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# UVSTAR

» Dual telescope with Rowland grating spectrographs and CCD detector assemblies, 50–125 nm



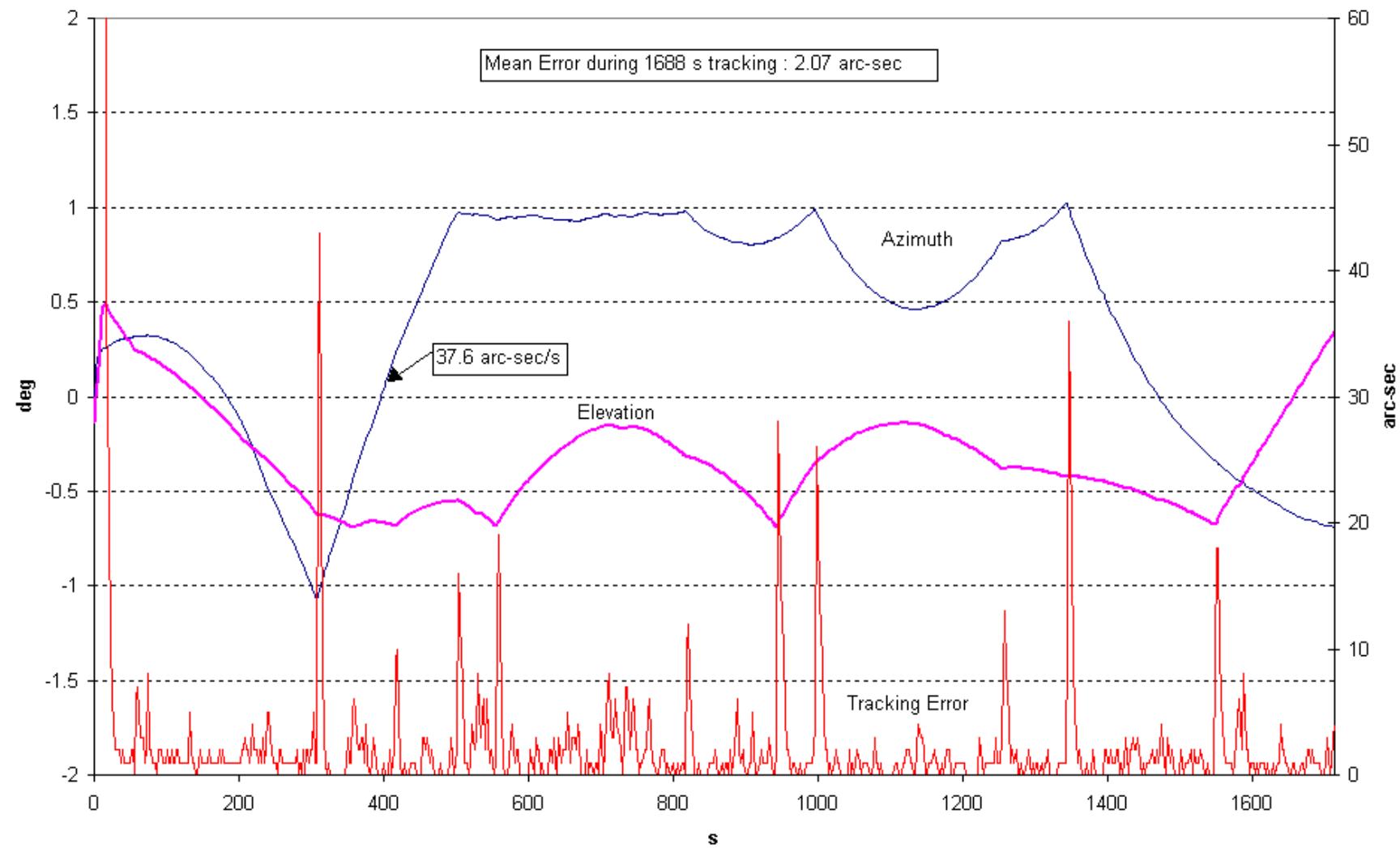
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## *UVSTAR: Instrument Characteristics*

- » EUV Spectral Range      *50 - 90 nm*
- » FUV Spectral Range      *85 - 125 nm*
- » Optics /Electronics
  - 2 reflections - 30 cm diameter primary mirrors*
  - SiC coatings on the primaries, BC on the gratings*
  - Open intensifiers with KBr photocathodes*
  - Optimum CCD's 1152 X 298 pixels*
- » Selectable resolution:    *0.1 nm, 0.45 nm, 1.2 nm*
- » Gimbaled telescope  $\pm 3^\circ$  two axis, central position  
 $+5^\circ$  above Shuttle +Y axis with tracking capability
- » Tracking accomplished with dual tracking telescopes:  $6^\circ \times 4.5^\circ$  FoV and  $0.25^\circ \times 0.32^\circ$  FoV

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# UVSTAR: Pointing & Tracking



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# *UVSTAR spectral resolution*

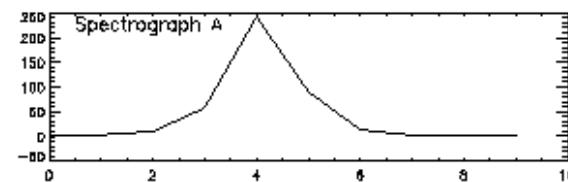
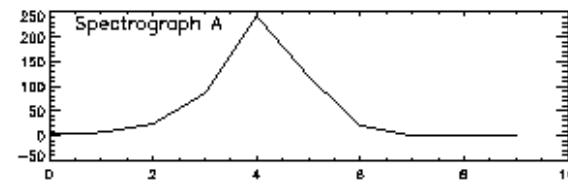
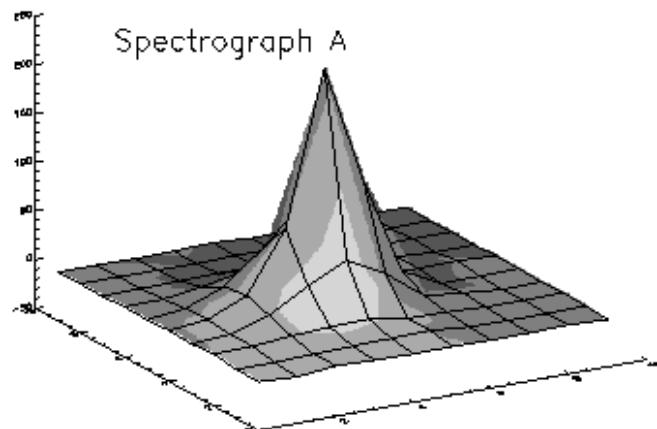


Figure 1. Single-event brightness profile for the EUV spectrograph.

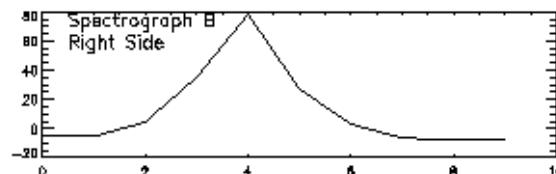
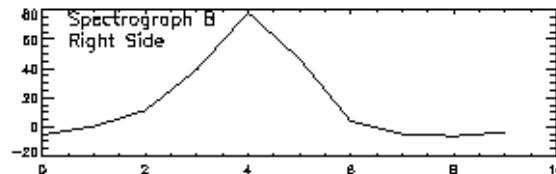
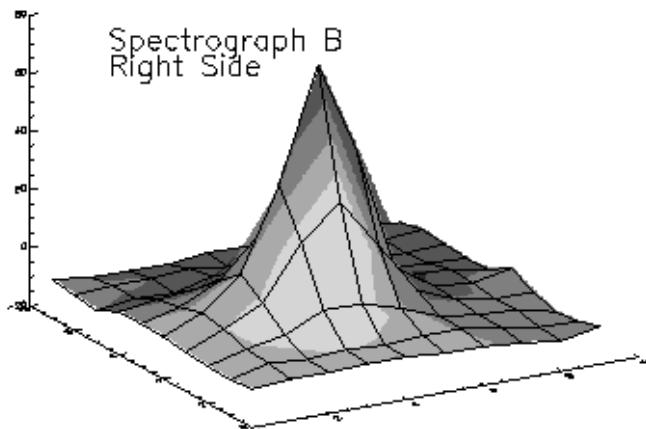


Figure 2. Single-event brightness profile for the FUV spectrograph, short-wavelength end.

# *UVSTAR RESULTS*

- » *UVSTAR-1 (11 day mission) : two failures limited instrument performances and science return*
  - *Mechanical/elevation drive failure -> inability to track a star*
  - *Electrical star/finder failure -> inability to identify the pointing direction*

*Because of these failures, UVSTAR only acquired spectra in a "passive" mode: 2 targets*
- » *UVSTAR-2 (11 day mission) : 34 targets pointed and tracked successfully (including Hale-Bopp comet)*
- » *UVSTAR-3 (9 day mission) : 47 targets pointed and tracked successfully (including EUV sources)*
- » *ALWAYS: Night/day continuous monitoring of the Earth glows at both low and high resolution*

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# *UVSTAR : SdO Stars*

## » *BD+28°4211*

- Secondary flux standard
- Observed previously (at wavelengths below 115 nm) by the Voyager UVS's, Cook's et al. absolutely calibrated sounding rocket, HUT

## » *NGC 246*

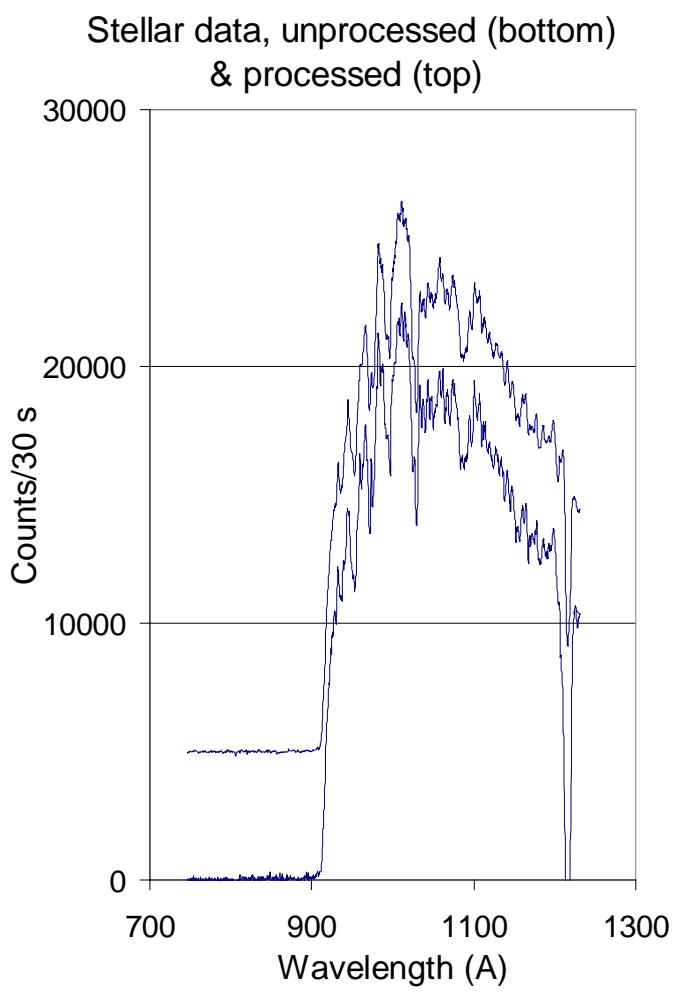
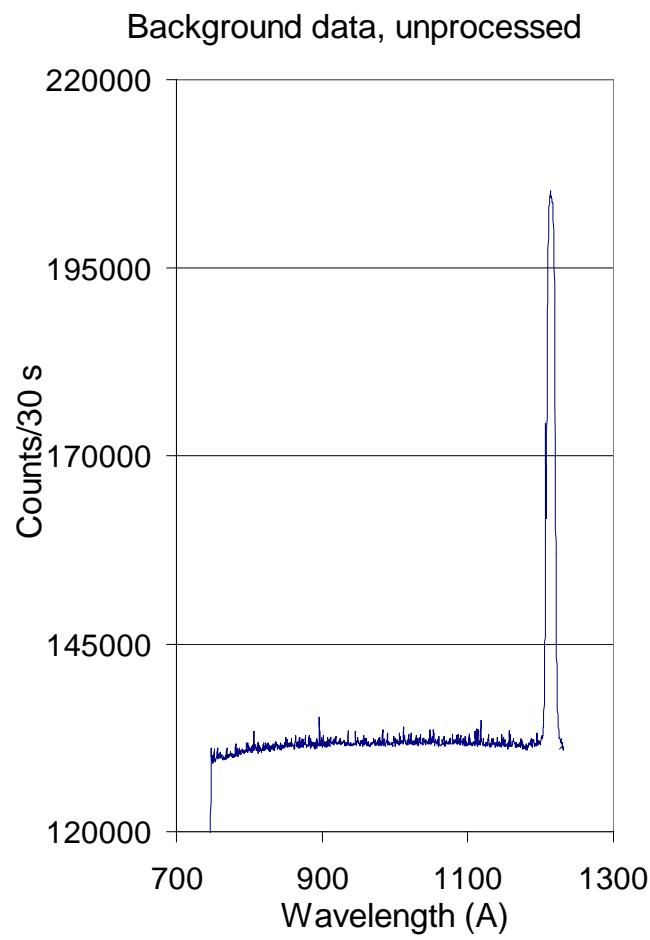
- Planetary nebula (diameter = 245 arcsec),
- Central star is of PG1159 type
- Among hottest PN nuclei ( $T_{\text{eff}}=150000$  K,  $\log g=5.7$ )
- Optical spectrum characterized by OVI emission lines
- EUV, X-ray source
- Some evidence of wind in CIV (IUE data)

## » *BD-11°162*

- $V=11.2$ ,  $B-V=-0.1$

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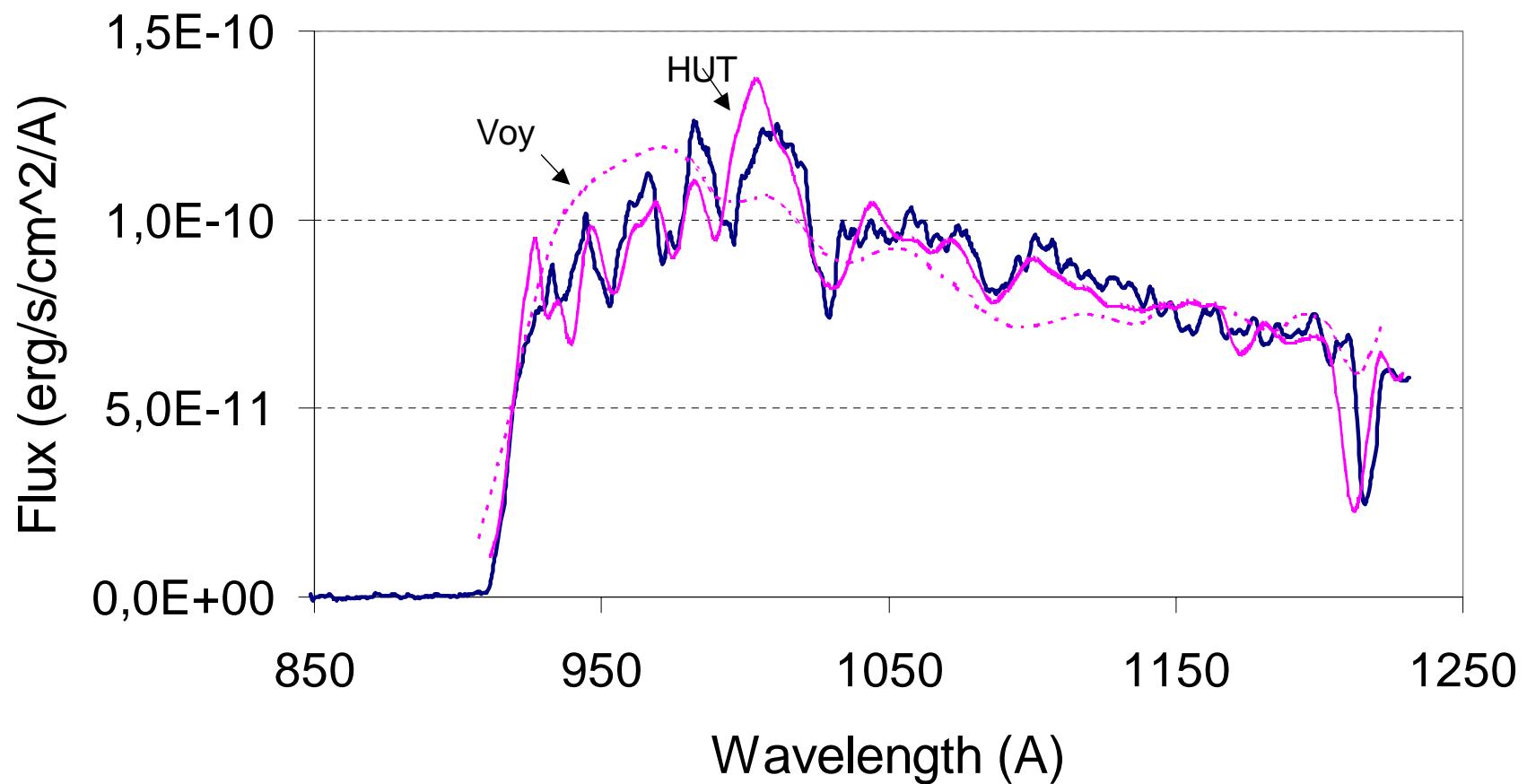
# ***BD +28°4211***



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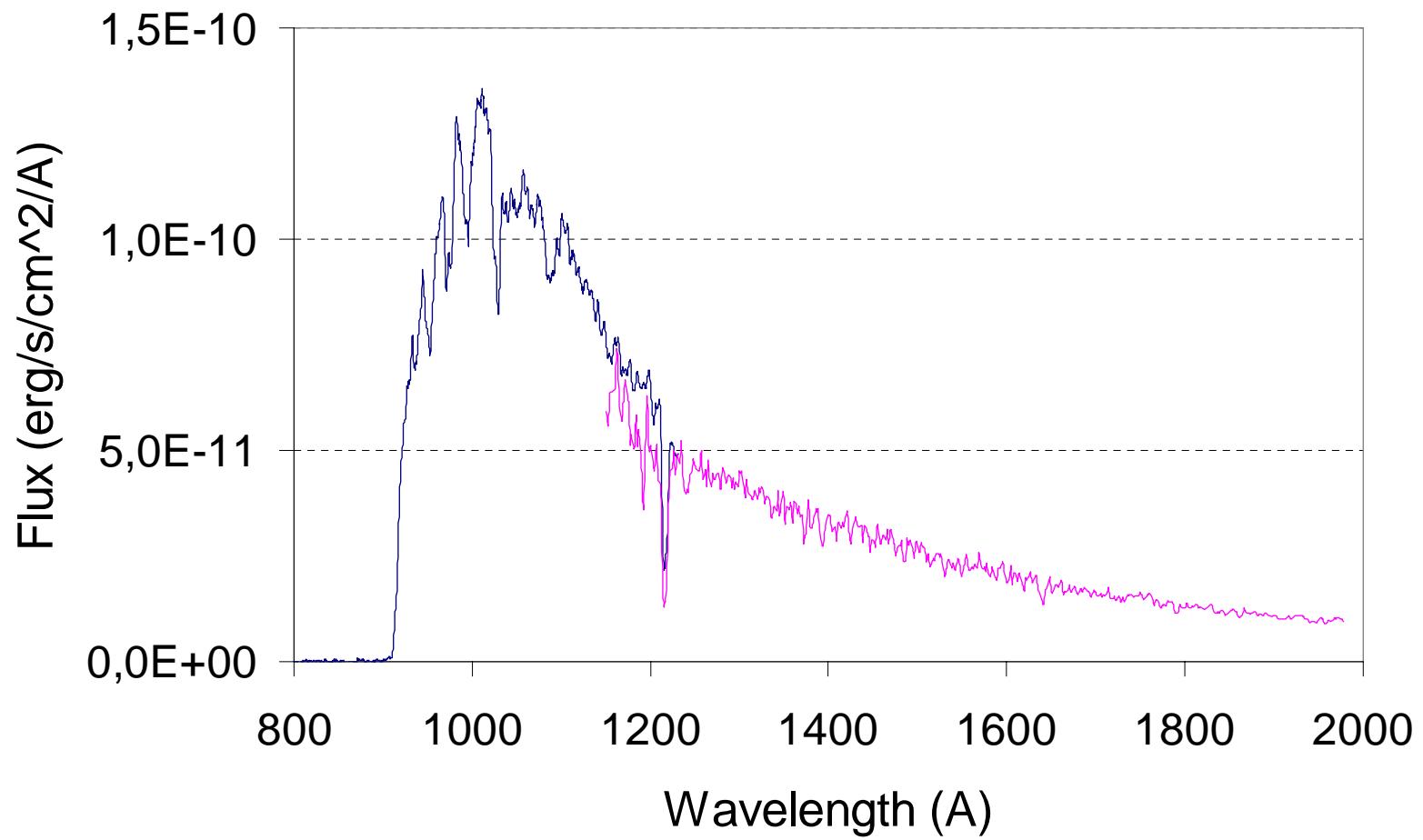
# ***BD +28°4211***

Calibrated flux & comparison with HUT and Voyager



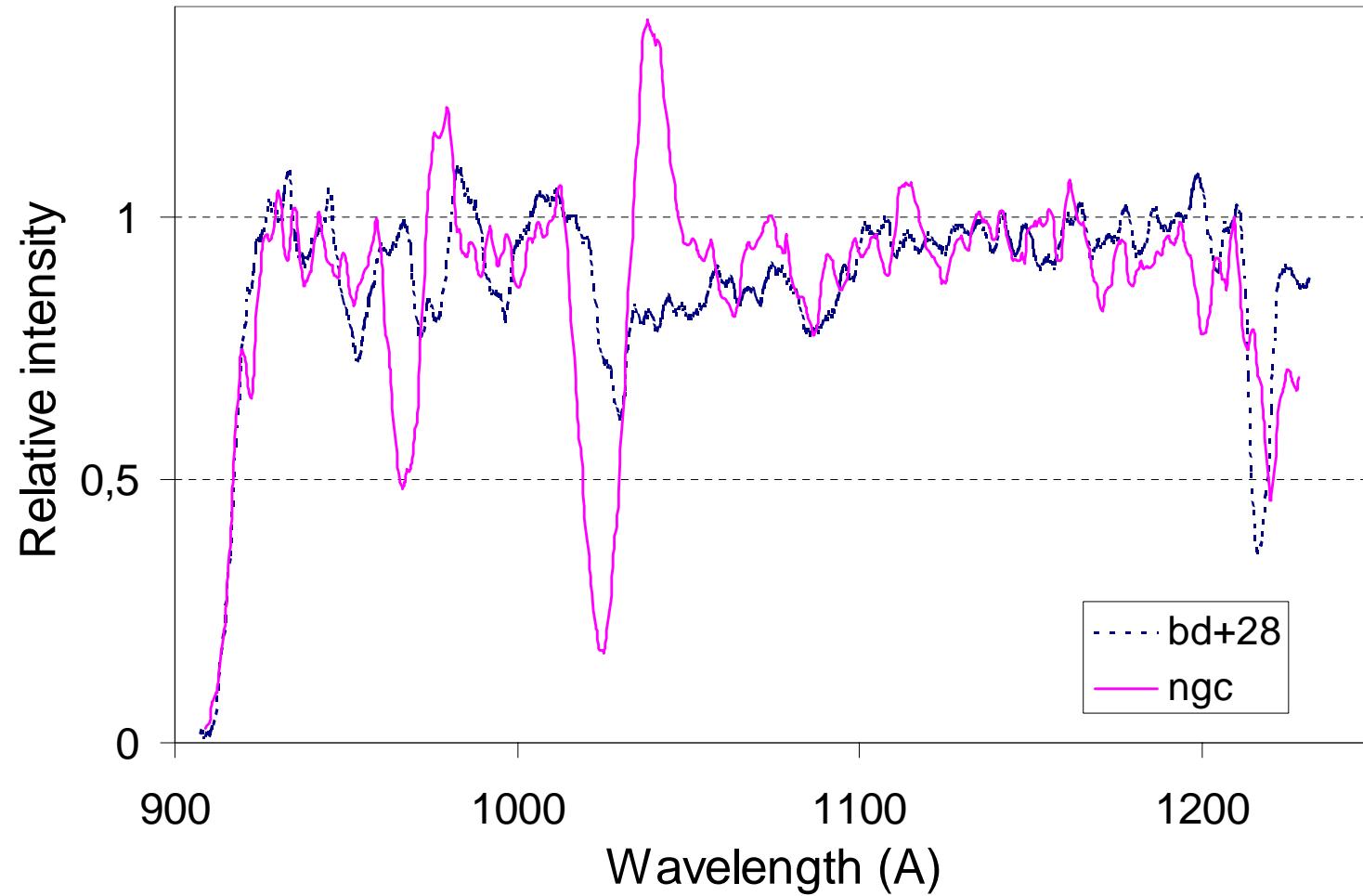
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# *BD +28°4211: UVSTAR and IUE*



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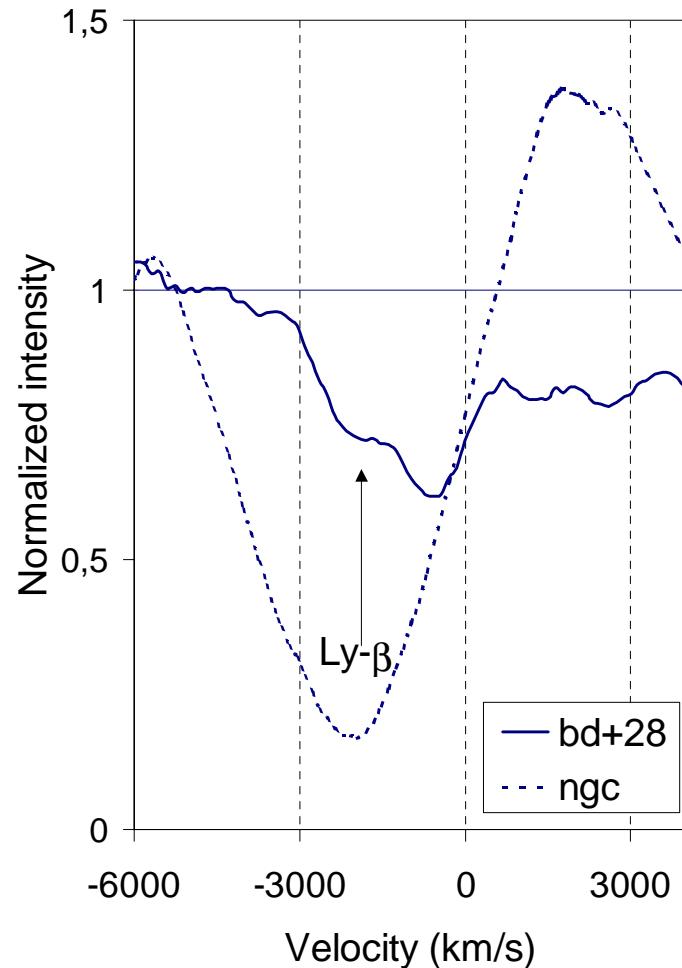
# *Normalized fluxes: BD +28°4211, NGC 246*



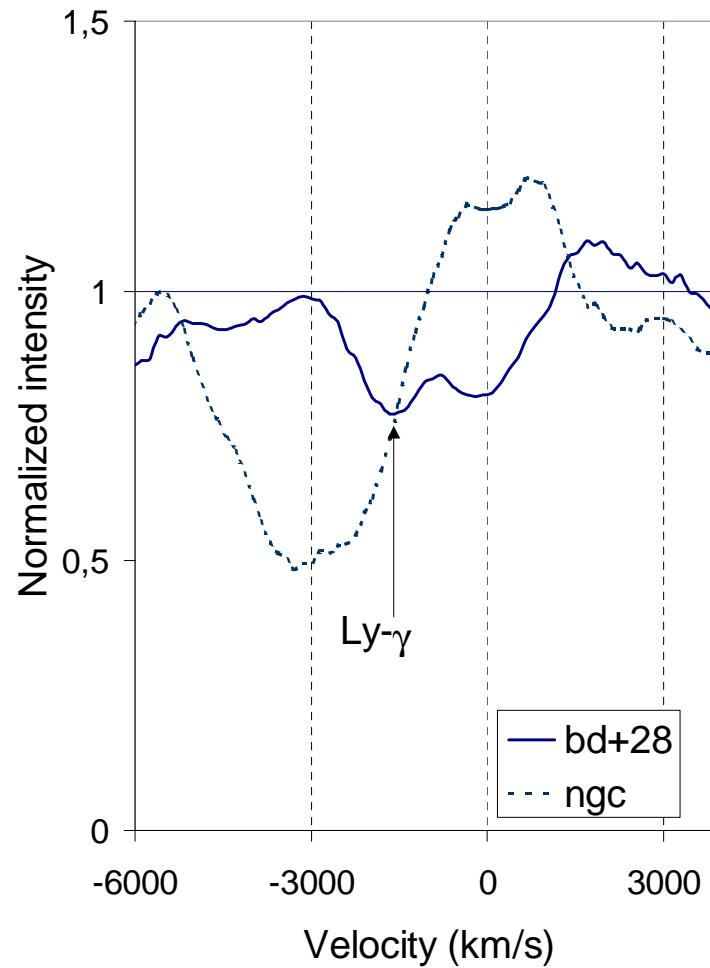
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# *Wind lines: NGC 246 vs BD +28°4211*

OVI - 1032



CIII - 977



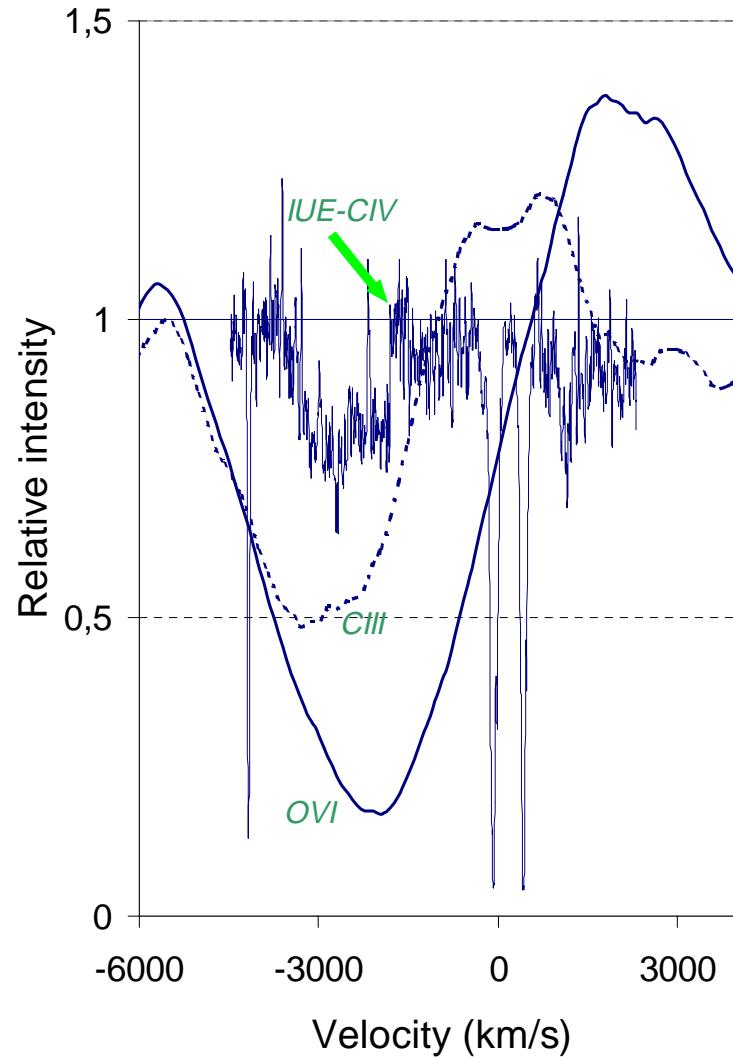
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# Wind lines: NGC 246

*Observed previously in  
CIV - 1548 by IUE @  
 $V_{wind} = 3700 \text{ km/s}$*

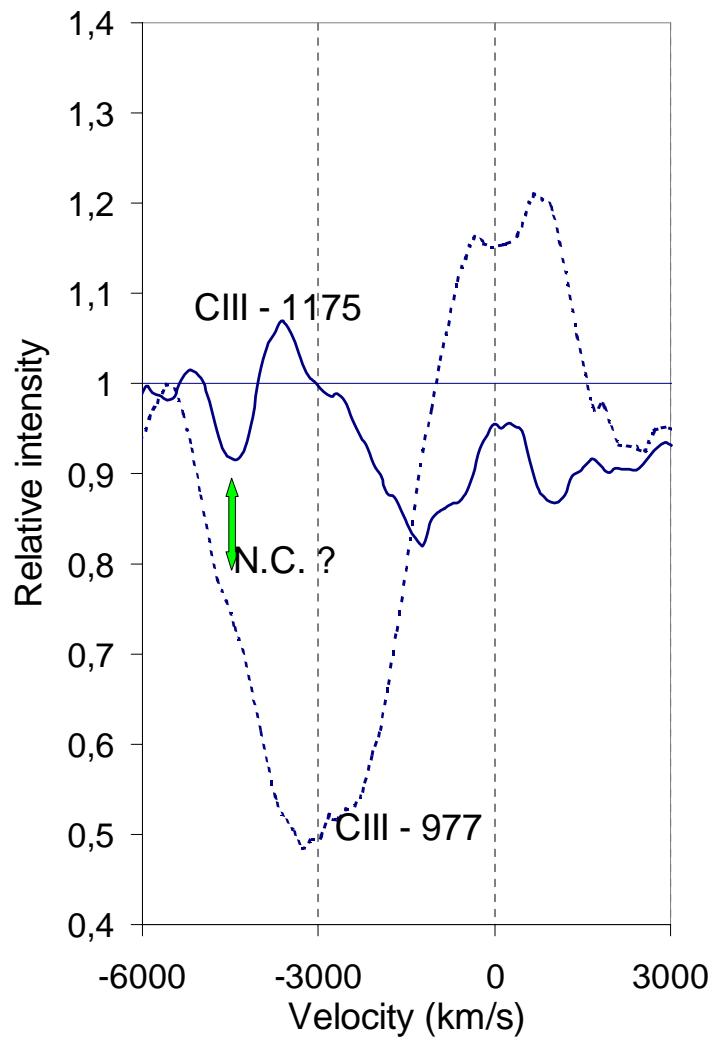
*UVSTAR measured OVI -  
1032 and CIII - 977 @  
 $V_{wind} = 5650 \text{ km/s}$*

*Concomitant presence of  
comparably strong CIII  
and OVI and relatively  
weak CIV*



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# *NGC 246 - CIII lines*



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# NGC 246 - Mass loss rates

## » Koesterkoe and coworkers (AA 339, 1998 & ApJ 500, 1998)

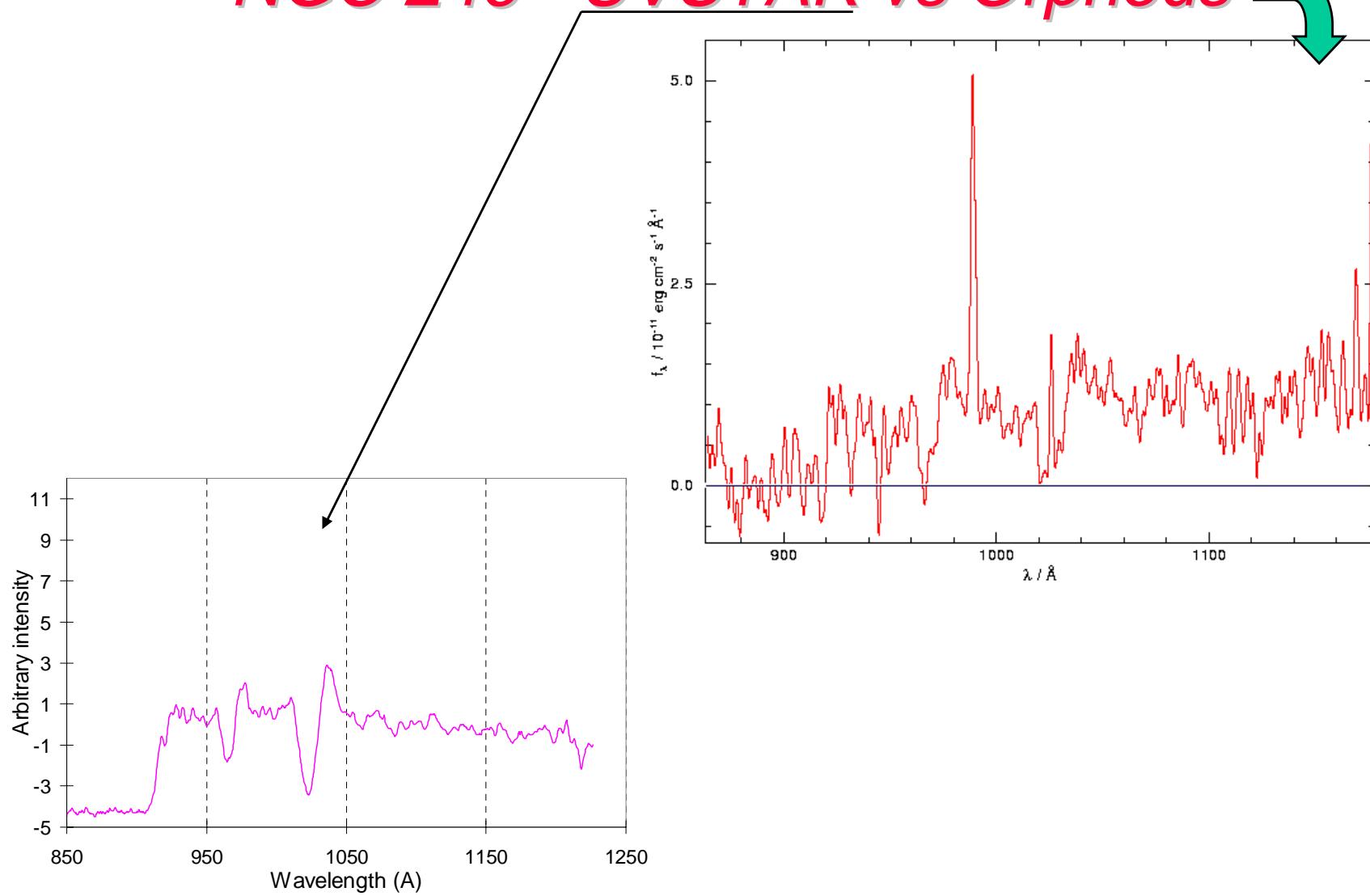
- From IUE (CIV), Orpheus (OVI) derive  $V_{wind} = 3500 \text{ km/s}$ ,  
 $dM/dt = 1.25 \cdot 10^{-7} M_{\text{sun}}/\text{year}$
- $dM/dt$  from 1) spherically symmetric, homogeneous and stationary wind, 2) non-LTE conditions with complex atomic models, 3) radiation driven pressure velocity field with  $\beta = 0.4$

## » UVSTAR results

- Wind velocity is larger by a factor of at least 1.5
- Ionization equilibria more complex than in above study
- NGC result for CIII/OVI is not unique; see Figure 2 in Koesterkoe & Werner (ApJ 500; Orpheus data of a set of PG 1159 stars) and BD-11°162 (a serendipitous UVSTAR target)

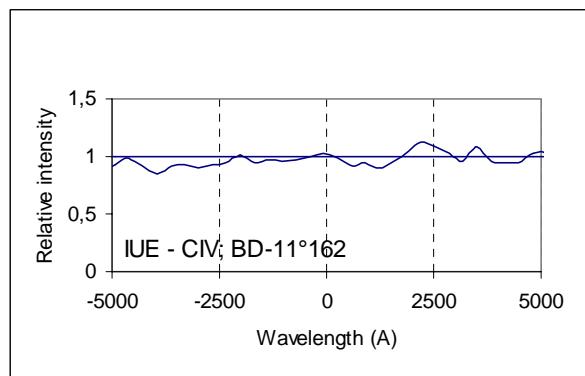
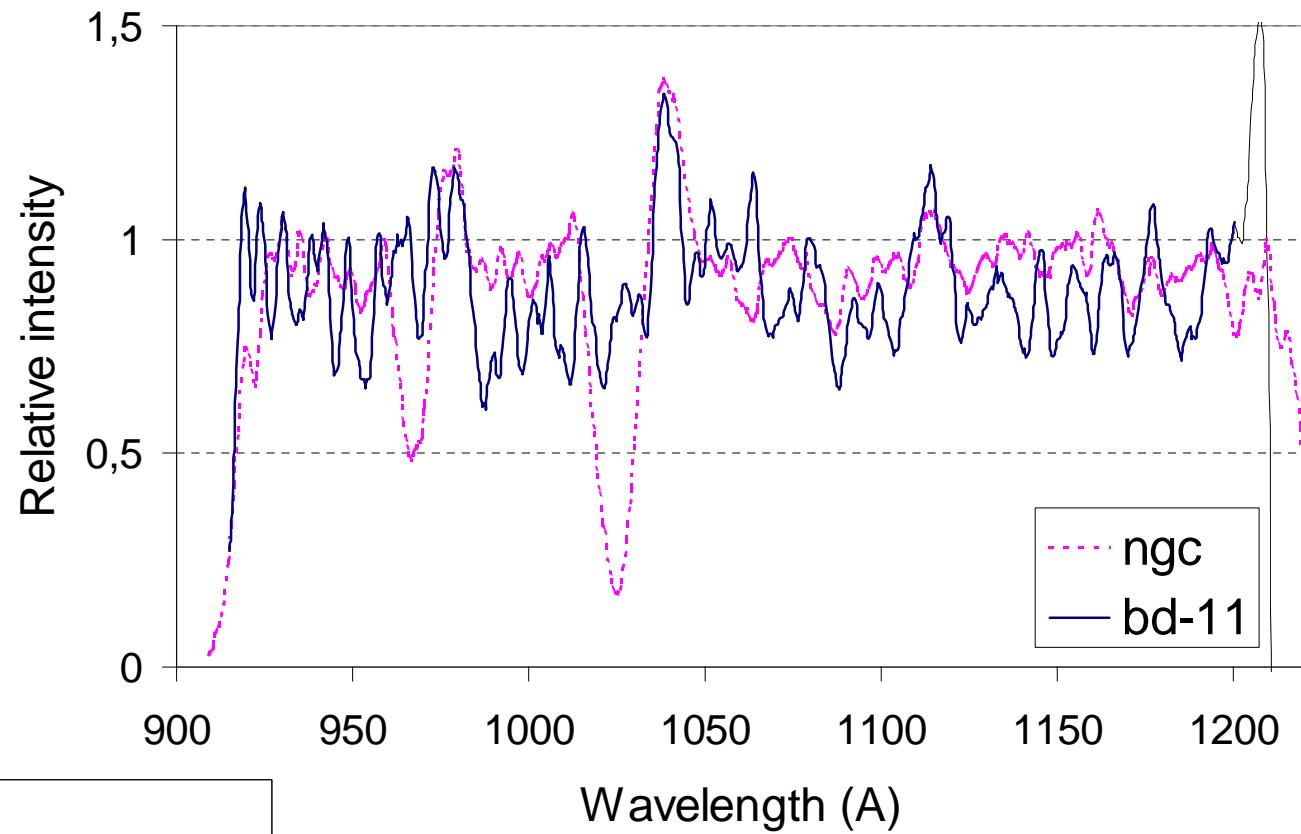
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# *NGC 246 - UVSTAR vs Orpheus*



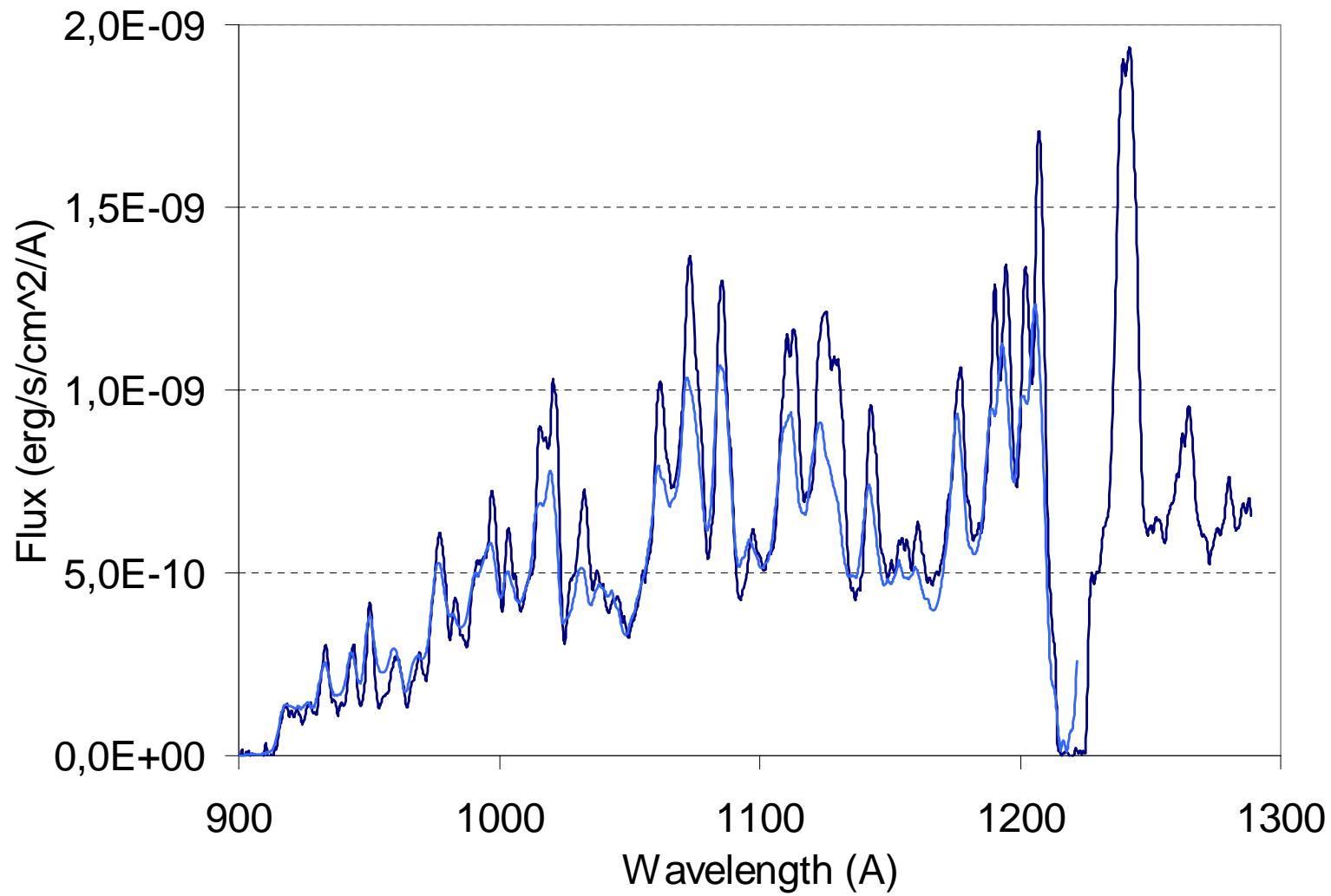
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# Normalized fluxes: BD -11°162, NGC 246



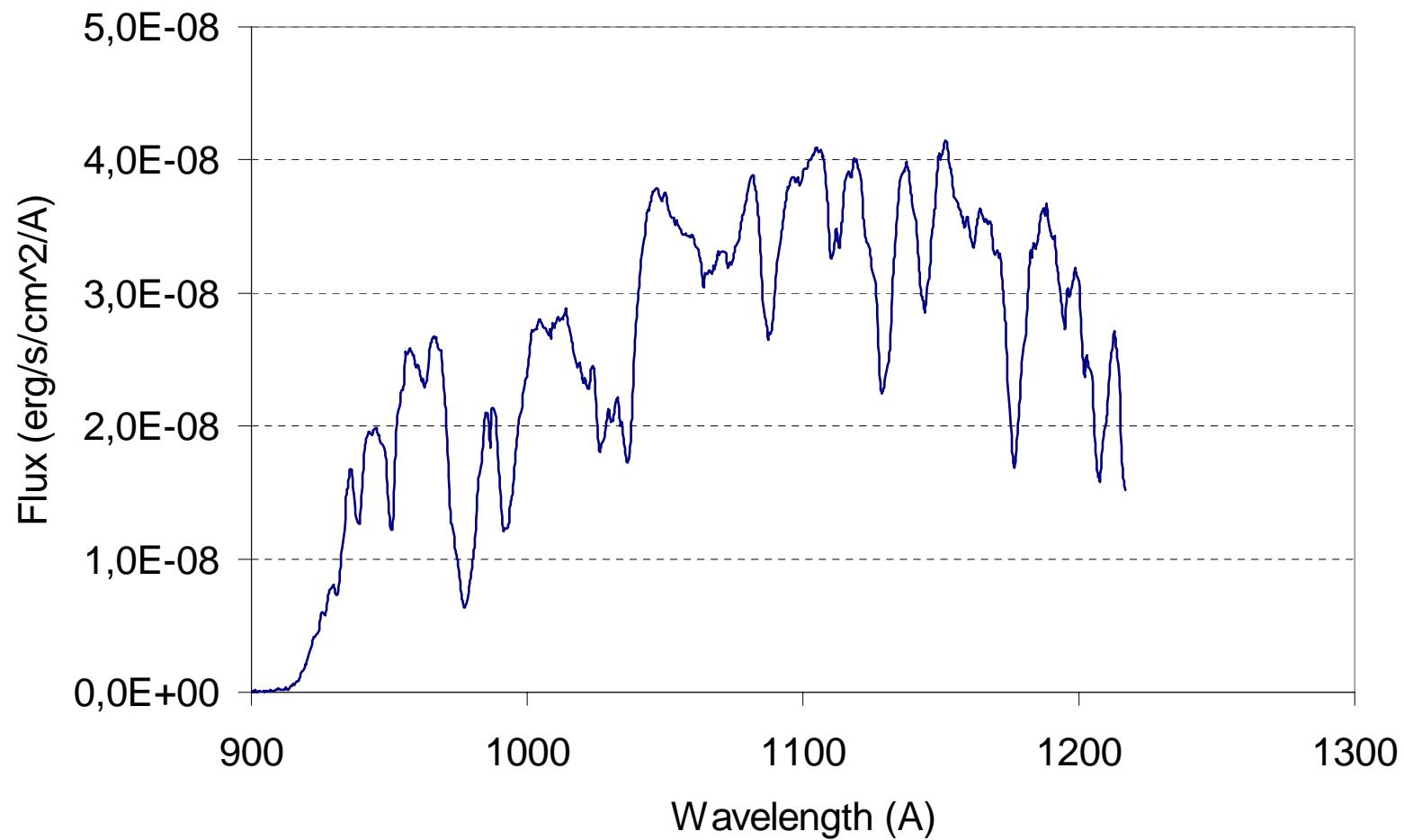
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# $\beta$ Lyr



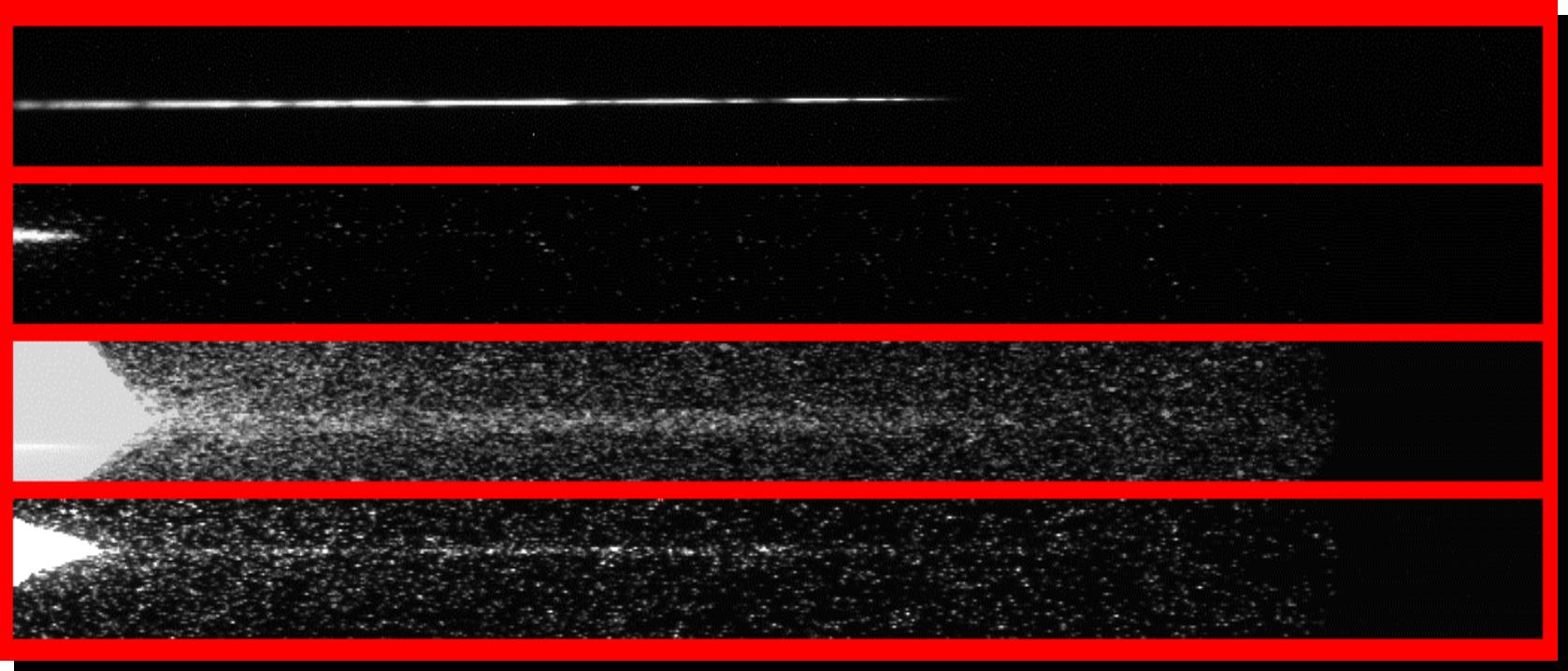
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# *Adhara ( $\varepsilon$ Cma)*



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# *Adhara: STS 95 on Nov. 4, 1998*



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